

Cirripedia Thoracica: New ranges and species of Verrucomorpha from the Indian and Southwest Pacific Oceans

John S. BUCKERIDGE

UNITEC Institute of Technology
Private Bag 92095, Auckland, New Zealand

ABSTRACT

Verrucomorpha from deep sea collections made by several French cruises to New Caledonia, Loyalty Ridge, Vanuatu, Wallis Island and Futuna Islands, Comoro Islands, and by the French-Indonesian cruise KARUBAR in Indonesian waters, over the period 1985-1994, are investigated. Fourteen species of verrucid are described, including four new species, *Verruca jago*, *AltiVERRUCA jonesae*, *Brochiverruca crosnieri* and *Metaverruca maclaughlinae*; the bathymetric and geographic ranges of verrucid taxa are extended, and it is confirmed that this is one of the most diverse verrucomorph faunas known. The status of both *Verruca* and *Metaverruca* is considered, and a revised key to genera of the Verrucidae is given.

RÉSUMÉ

Cirripedia Thoracica: Nouvelles répartitions et nouvelles espèces de Verrucomorpha de l'océan Indien et du Sud-Ouest Pacifique.

Les Verrucomorphes, principalement bathyaux, récoltés entre 1985-1994, lors de diverses campagnes françaises au large de la Nouvelle-Calédonie et de la Ride des Loyauté, au Vanuatu, aux îles Wallis et Futuna, à la Grande-Comore, ainsi que lors de la campagne franco-indonésienne KARUBAR en Indonésie orientale, sont étudiés. Quatorze espèces ont été trouvées, parmi lesquelles quatre sont nouvelles pour la science : *Verruca jago*, *AltiVERRUCA jonesae*, *Brochiverruca crosnieri* and *Metaverruca maclaughlinae*. Il se confirme que la faune des Verrucomorphes étudiée ici est l'une des plus diversifiée connue dans une même région. Les distributions bathymétriques et géographiques de plusieurs espèces sont étendues. Le statut des genres *Verruca* et *Metaverruca* est examiné, et une nouvelle clé des genres de la famille Verrucidae est proposée.

INTRODUCTION

The deep sea verrucomorph cirripede fauna of Indonesia, New Caledonia and the Wallis and Futuna Islands has recently been described by BUCKERIDGE (1994), in which earlier work in the region is cited. This paper records

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previously unsorted material collected from New Caledonian waters by BIOCAL (1985), MUSORSTOM 6 (1989), BATHUS 1 (1993), BATHUS 2 (1993), BATHUS 3 (1993), BATHUS 4 (1994) and HALIPRO 1 (1994); from Vanuatu by MUSORSTOM 8 (1994); from the Wallis and Futuna Islands region by MUSORSTOM 7 (1992); from the Loyalty Ridge by MUSORSTOM 6 (1989); from Grande-Comore (in the Indian Ocean) by JAGO-COELACANTHE (1989) and from Indonesian waters by KARUBAR (1991) expeditions.

In addition, the study has been expanded to include verrucid material collected by the Western Australian Museum, Perth, Australia, from off northwestern Australia by R.V. "Soela" (1982, 1984). The decision to include western Indian Ocean material was based upon the need to compare the current collection, and that of BUCKERIDGE (1994), with *Verruca macani* Stubbings, 1936, a species which appeared similar to *Metaverruca* described in BUCKERIDGE (1994), but which had previously been only partially described. A first description of the soft parts of this species is provided here. The geographic region thus expanded, permitted a most intriguing new taxon from the Comore Islands to be included. With the exception of unusual varieties, only new species, or parts of taxa not previously illustrated, are figured in this paper.

The Verrucidae are a family of asymmetrical sessile barnacles characterised by six calcareous plates. The shell is made up of a carina and rostrum, plus a tergum and scutum, the latter two having moved from the operculum to become "fixed" as part of the shell wall. The remaining plates, a tergum and scutum (hereafter termed movable plates) make up the operculum. It appears to be totally random as to whether the "left" or "right" opercular plates move to complete the shell wall (DARWIN, 1854; BUCKERIDGE, 1994). However NEWMAN (1989) has demonstrated that in *Neoverruca* at least, the asymmetry is determined in the earliest juveniles by the side closest to the substratum.

TYPES: Holotypes of all new species are held by the Muséum national d'Histoire naturelle (prefix "MNHN-Ci") in Paris, France. Paratypes are also held by the Muséum national d'Histoire naturelle, and when numbers of specimens available permit, by the National Museum of Natural History, Washington DC, United States of America (prefix "USNM") and UNITEC Institute of Technology, Auckland, New Zealand (prefix "CAX").

In the lists of material examined the abbreviations for the gear used are: CP = beam trawl and DW = Warén dredge. The specimens from Grande-Comore were collected by the German submersible JAGO. The Western Australian Museum material was collected by Engel trawl. Grid references for the Western Australian material have been corrected to a single value, represented by degrees and minutes only.

LIST OF SPECIES

Genus *VERRUCA* Schumacher, 1817

Verruca albatrossiana Pilsbry, 1912

Verruca jago sp. nov.

Genus *ALTIVERRUCA* Pilsbry, 1916

Altiverruca cristallina (Gruvel, 1907)

Altiverruca jonesae sp. nov.

Altiverruca nitida (Hoek, 1883)

Genus *BROCHIVERRUCA* Zevina, 1993

Brochiverruca crosnieri sp. nov.

Genus *METAVERRUCA* Pilsbry, 1916

Metaverruca defayae Buckeridge, 1994

Metaverruca macani (Stubbings, 1936)

Metaverruca pacifica Buckeridge, 1994

Metaverruca plicata Buckeridge, 1994

Metaverruca recta (Aurivillius, 1898)

Metaverruca maclaughlinae sp. nov.

Genus *ROSTRATOVERRUCA* Broch, 1922

Rostratoverruca intexta (Pilsbry, 1912)

Rostratoverruca kruegeri (Broch, 1922)

SYSTEMATIC ACCOUNT

Superorder THORACICA Darwin, 1854

Suborder VERRUCOMORPHA Pilsbry, 1916

DIAGNOSIS. — Sessile thoracican cirripedes with asymmetrical shell wall comprising fixed scutum, fixed tergum, rostrum and carina, closed by movable scutum and movable tergum (Verrucidae), sometimes including rostrolatus and carinolatus on movable side (Proverrucidae), or basal whorls of imbricating plates (Neoverrucidae); basis membranous or calcareous.

Family VERRUCIDAE Darwin, 1854

(amend. NEWMAN & HESSLER, 1989)

DIAGNOSIS. — Verrucomorphans with primary wall (carina, rostrum, fixed scutum, fixed tergum), in contact with substratum; latera absent.

DISCUSSION. — There are currently seven genera recognised within the Verrucidae. Initially, PILSBRY (1916), recognised four "sections", which were subsequently elevated to subgenera (e.g. NEWMAN, ZULLO & WITHERS, 1969; FOSTER, 1978). BROCH, (1922) added *Rostratoverruca*, and ZEVINA (1987, 1993) added *Spongoverruca* and *Brochiverruca* respectively.

The presence of a myophore on the fixed scutum has been previously regarded by many workers as of considerable value in distinguishing between genera, e.g. PILSBRY (1916), ZEVINA (1987), BUCKERIDGE (1994), FOSTER & BUCKERIDGE (1995). Indeed, PILSBRY (1916) used this character to define his "Section A" *Metaverruca*, i.e.,

"The basal borders of the wall plates are inflexed, forming a wide basal ledge; the fixed scutum bears a depending tongue-shaped adductor ridge or myophore; the apex of the rostrum is marginal; top flattened; sculpture weak".

However, as Paulo YOUNG has pointed out (pers. comm.), PILSBRY failed to stress that his *Lepas stroemia* Müller, 1776, the type for "Section B" *Verruca*, also possesses a myophore. If this is taken into account, then PILSBRY's diagnosis for *Verruca s.s.* is less than satisfactory, i.e.,

"Top flattened, the plane of the movable plates not far from parallel with that of the base; radio-alar area between fixed scutum and fixed tergum small or linear".

Of the points stressed in the above two diagnoses, it must be noted that:

1. If the apex of the rostrum is not marginal, the species cannot be *Verruca*, rather it is either *Rostratoverruca* or *Brochiverruca*.

2. The basal ledge is a difficult character to use to distinguish *Verruca* and *Metaverruca*, as a number of *Verruca s.s.* (see in PILSBRY, 1916), have slightly thickened basal edges to the shell wall, e.g. *Verruca alba* Pilsbry, *Verruca calotheca* Pilsbry, *Verruca entobapta* Pilsbry.

3. The radio-alar area between fixed scutum and fixed tergum does not appear to be particularly linear in some *Verruca s.s.*, e.g. *V. entobapta*.

It should also be noted that the angle of the operculum to the base may vary a little, particularly where the nature of the substrate appears to have a strong influence. However, I firmly believe that *Verruca* and *Metaverruca* are distinct. Key features that distinguish *Metaverruca* are the presence of **all** of the following characters:

- thickened basal ledge on the compartments (this is often so well developed that it is very difficult to disarticulate the shell evenly along compartmental sutures).
- a distinctive D-shaped orifice, with opercular hinge straight.
- shell shape "box-like".
- operculum nearly parallel to base.
- a well developed myophore on the fixed scutum.

Although each of these characters may be found in *Verruca*, they are only found **together** in *Metaverruca*. Clearly juveniles of *Metaverruca* will not necessarily possess all features, but it would be most cumbersome in a diagnosis of a genus to include all stages of ontogeny. A revised key is provided below, which permits differentiation between the genera.

In the past, numerous workers have spent considerable time in primary descriptions, detailing the number of interlocking ridges between the carina and rostrum. Whilst there is some validity in considering these aspects, they should only be taken as a guide, for in species like *Metaverruca recta*, (for which there is now a very large amount of comparative material), one can distinguish a series (not necessarily solely ontogenetic) that shows a range from one or two very flat ridges to more than five (see BUCKERIDGE 1994, fig. 13). The spacing of growth lines may also be misleading (see under *Metaverruca recta*). However, one feature that does appear consistent, except in the most juvenile of specimens, is the number of interlocking ribs (or ridges) on the movable opercula. These very quickly reach an optimal number and are not known to add further ribs, even in very large specimens.

Morphology of the soft parts can be of considerable help in distinguishing species, particularly of *Metaverruca*. However, most taxa described here may be identified on shell morphology alone. The nomenclature used in this paper follows that of BUCKERIDGE, 1994, fig. 1. The use of a "+" in the cirral counts indicates that the cirrus is incomplete, and "c.a." refers to caudal appendages.

STRATIGRAPHIC RANGE. — ?Middle, Upper Cretaceous to Recent, Europe, South America, Australasia.

DISTRIBUTION. — Cosmopolitan in present seas.

Key to genera of the Verrucidae

- | | |
|---|------------------------|
| 1. Rostral apex marginal | 2 |
| — Rostral apex removed from margin | 3 |
| 2. Operculum nearly vertical to base | 4 |
| — Operculum nearly parallel to base | 5 |
| 3. Carinal apex marginal..... | <i>Rostratoverruca</i> |
| — Carinal apex removed from margin | <i>Brochiverruca</i> |
| 4. Myophore present on fixed scutum | <i>Cameraverruca</i> |
| — Myophore absent on fixed scutum | 6 |
| 5. Shell box-like, with thickened, inflected basal margin and D-shaped aperture . | <i>Metaverruca</i> |
| — Shell low conic, with non-linear hinge-line | <i>Verruca</i> |
| 6. Not embedded in sponge | <i>Altiverruca</i> |
| — Embedded in sponge | <i>Spongoverruca</i> |

Genus *VERRUCA* Schumacher, 1817

Verruca "Section B" - PILSBRY, 1916: 23.

Verruca (*Verruca*) - NEWMAN ZULLO & WITHERS, 1969: R281. — FOSTER, 1978: 68.

Verruca - ZEVINA 1987: 1812. — NEWMAN & HESSLER, 1989: 268.

DIAGNOSIS. — Verrucids with shell form depressed; apices of rostrum and carina marginal; operculum parallel to base.

TYPE SPECIES. — *Lepas stroemia* Müller, 1776. North Atlantic, northern Europe, Mediterranean, ?Red Sea, intertidal - 500 m.

SPECIES. — Twenty eight taxa are presently assigned to this genus, († indicates extinct taxa): *Verruca alaskana* Pilsbry, 1943; *V. alba* Pilsbry, 1907; *V. alba caribbea* Pilsbry, 1916; *V. alba barbadensis* Pilsbry, 1916;

V. albatrossiana Pilsbry, 1912; *V. calotheca* Pilsbry, 1907; *V. calotheca flavidula* Pilsbry, 1916; *V. calotheca heteropoma* Pilsbry, 1916; *V. calotheca niasiensis* Nilsson-Cantell, 1929; *V. cookei* Pilsbry, 1927; *V. floridana* Pilsbry, 1916; *V. grimaldi* Gruvel, 1920; *V. laevigata* (Sowerby, 1827); †*V. nuciformis* Buckeridge, 1983; †*V. prisca* Bosquet, 1853; †*V. pusilla* Bosquet, 1857; †*V. rocana* Steinmann, 1921; *V. sinuosa* Foster & Buckeridge, 1995; *V. spengleri* Darwin, 1854; *V. stroemia* (Müller, 1776); †*V. tasmanica* Buckeridge, 1983; †*V. tasmanica chatheca* Buckeridge, 1983; *V. trisulcata* Gruvel, 1920; *V. xanthia* Pilsbry, 1916; *V. xanthia insculpta* Pilsbry, 1916; *V. entobapta* Pilsbry, 1916; *V. scrippsae* Zullo, 1964; plus the new species described here: *V. jago* sp. nov.

Remarks: †*Verruca withersi* Newman & Schram, 1980 (included in the listing for *Verruca sensu stricto* in BUCKERIDGE, 1994) has been re-evaluated and interpreted as "non-verrucid" in BUCKERIDGE, 1996. The generic status of a further group of verrucids, comprising *V. aequalis* Aurivillius, 1898; *V. cornuta* Aurivillius, 1898; *V. costata* Aurivillius, 1898, is uncertain.

DISCUSSION. — The genus *Verruca* is a grouping of convenience. In this sense, the taxa within it are rather discordant. It is clear that future revision will require the genus to be split, with perhaps only *V. cookei*, *V. jago* sp. nov., *V. laevigata*, *V. spengleri*, *V. stroemia*, and some fossil taxa remaining in *Verruca sensu stricto*, the remaining being placed in at least one new genus (see BUCKERIDGE, 1994).

STRATIGRAPHIC RANGE. — Cretaceous (Australia, New Zealand, Columbia, western Europe), Palaeogene (New Zealand, Argentina, Chatham Islands) to Recent.

DISTRIBUTION. — Pacific, North Atlantic, Mediterranean, Caribbean, ?Red Sea, Indian Ocean, intertidal - 620 m.

Verruca albatrossiana Pilsbry, 1912

Verruca albatrossiana Pilsbry, 1912: 292.

Verruca (Eu-Verruca) albatrossiana - BROCH, 1922: 290, figs 39-40.

Verruca grex Hoek, 1913: 142, pl. 11, figs 7-13, pl. 13, figs 11-13.

Verruca albatrossiana - BUCKERIDGE, 1994: 91, figs 1a-f.

MATERIAL EXAMINED. — **Indonesia**. KARUBAR: stn CP 17, 05°15'S, 133°01'E, 439-459 m, 24.10.1991: 1 specimen on a cidaroid spine.

NW Australia. "Soela": WAM 909-86, 13°33'S, 122°14'E, 494-496 m, 13.2.1984: 11 specimens, on cidaroid spines.

DIAGNOSIS. — *Verruca* with rostrum and carina low, strongly developed longitudinally to give shell oblique appearance; fixed scutum considerably larger than fixed tergum, opercular plates displaced carinally.

DISCUSSION. — This material conforms to that described in BUCKERIDGE (1994). This is the first record of the species from northwestern Australia.

DISTRIBUTION. — Indo-Pacific, 345-620 m.

Verruca jago sp. nov.

Fig. 1 a-m, 8 e-i.

MATERIAL EXAMINED. — **Grande-Comore**. JAGO-COELACANTHE: stn at 11°51'S, 43°20'E, 203 m, 1.12.1989: 4 specimens. — Stn at 11°50'S, 43°21'E, 196 m, 8.12.1989: 4 specimens.

TYPES. — *Holotype*: MNHN-Ci 2425, r-c diameter: 2.9 mm; height: 0.4 mm (from 11°51'S, 43°20'E).

Paratypes: MNHN-Ci 2426, r-c diameter: 2.27 mm; height: 0.25 mm (1 specimen, from 11°51'S, 43°20'E); MNHN-Ci 2431 (3 specimens, from 11°50'S, 43°21'E); CAX 108 (1 specimen, from 11°50'S, 43°21'E); USNM 282635 (2 specimens, from 11°51'S, 43°20'E).

DIAGNOSIS. — Small, flattened *Verruca*; shell with regularly disposed, large punctae; movable tergum quadrangular, 3 ribs; fixed scutum with large myophore; movable scutum triangular, with 3 ribs, occludent portion lacking ribbing, internally with elevated depression for adductor muscle attachment; rami of cirrus I spatulate.

DESCRIPTION. — *Verruca* with shell white, translucent, low conic, weakly to moderately plicate, patterned with fine circular tubes (punctae), which extend from exterior (infilled with chitinous material), to open to interior as very small pores; punctae generally separated by at least own diameter and arranged as rows along leading edge of sub-parallel, concentric growth lines; shell wall comprised of up to 7 calcareous lamellae (particularly clear in basal view of rostrum of Ci 2431); operculum sub-parallel to base; rostrum and carina articulating with up to 2 ribs; basis membranous. Fixed scutum with large, well formed myophore for adductor muscle attachment; fixed tergum low, internally with small horizontal ledge, although not as well developed as myophore in fixed scutum; movable tergum quadrangular, with well defined apico-basal rib, plus 2 secondary ribs, interlocking with movable scutum; articular margin slightly concave; movable scutum triangular, with 2 ribs interlocking with tergum and further adjacent curved, apico-basal rib terminating at rostro-carinal suture, occludent portion lacking ribbing, internally with elevated depression for adductor muscle attachment.

Mandible tridentate, lower angle pectinate, with 2 moderately large basal spines; first maxilla with 2 large and 2 medium upper spines, moderate to weakly formed notch, lower angle with 2 large and 3 medium spines; labrum gently arched, with single large tooth on either side and at least 4 smaller, bidentate teeth centrally; palps with 3-4 terminal spines, not meeting across labrum.

Cirri possess the following number of segments (r-c being the rostro-carinal diameter):

r-c (mm)	I	II	III	IV	V	VI	c.a.
2.27	7, 6	5, 9	12, 14	12, 14	13, 14	13, 13	5

Cirrus I with both rami heavily hirsute, moderately spatulate, cirri I and II with anterior rami shorter than posterior rami, although in cirrus I with more segments.

Length of caudal appendages about twice that of basal segment of pedicel of cirrus VI; penis very large, occupying significant part of mantle cavity, with numerous terminal setae and scattered tufts of long setae; eggs present in holotype, larvae in mantle cavity of Ci 2431a.

DISCUSSION. — The interesting features of this species are the punctae, or pores, the horizontal ledge on the tergum, the spatulate rami on the first cirri and the very large penis. Although the latter is likely a reflection of the current sexual activity of the specimens studied, it was proportionally larger than any other I have viewed in the *Verrucidae*. The presence of a ledge on the inner surface of the fixed tergum, although not unique (*Verruca stroemia* has one), is rare. In addition, some specimens of *Verruca jago* sp. nov. are remarkably flat. Paratype Ci 2426, from which the soft parts were drawn, had a shell height of only 0.25 mm.

The most distinctive character about this species is the small punctae that are regularly disposed over the entire shell. The shell is translucent in many specimens, and with a stereomicroscope, it is possible to focus through the punctae, and to perceive them as pores. The punctae narrow as they approach the inner side of the wall, and open to the interior. Although under light microscopy, most punctae appear to be closed to the exterior, examination under the scanning electron microscope (following the desiccation and electrolytic coating process) shows that soft tissue extends to the exterior (fig. 8g-i). In regions of higher corrosion, such as around the apices of plates, the punctae form slightly raised granules. In light of this, it is suggested that the tissue (probably chitinous) has some mitigating effect on erosion rates.

The inner surface of the plates of some other species within *Verruca* are characterised by chitin filled pores (e.g. *Verruca laevigata*, *Verruca stroemia*). However the pores in *V. jago* sp. nov. are at least twice the diameter of those observed in any others, and differ further by being clearly visible on the exterior surface, a feature generally restricted to of worn, or juvenile specimens of other species.

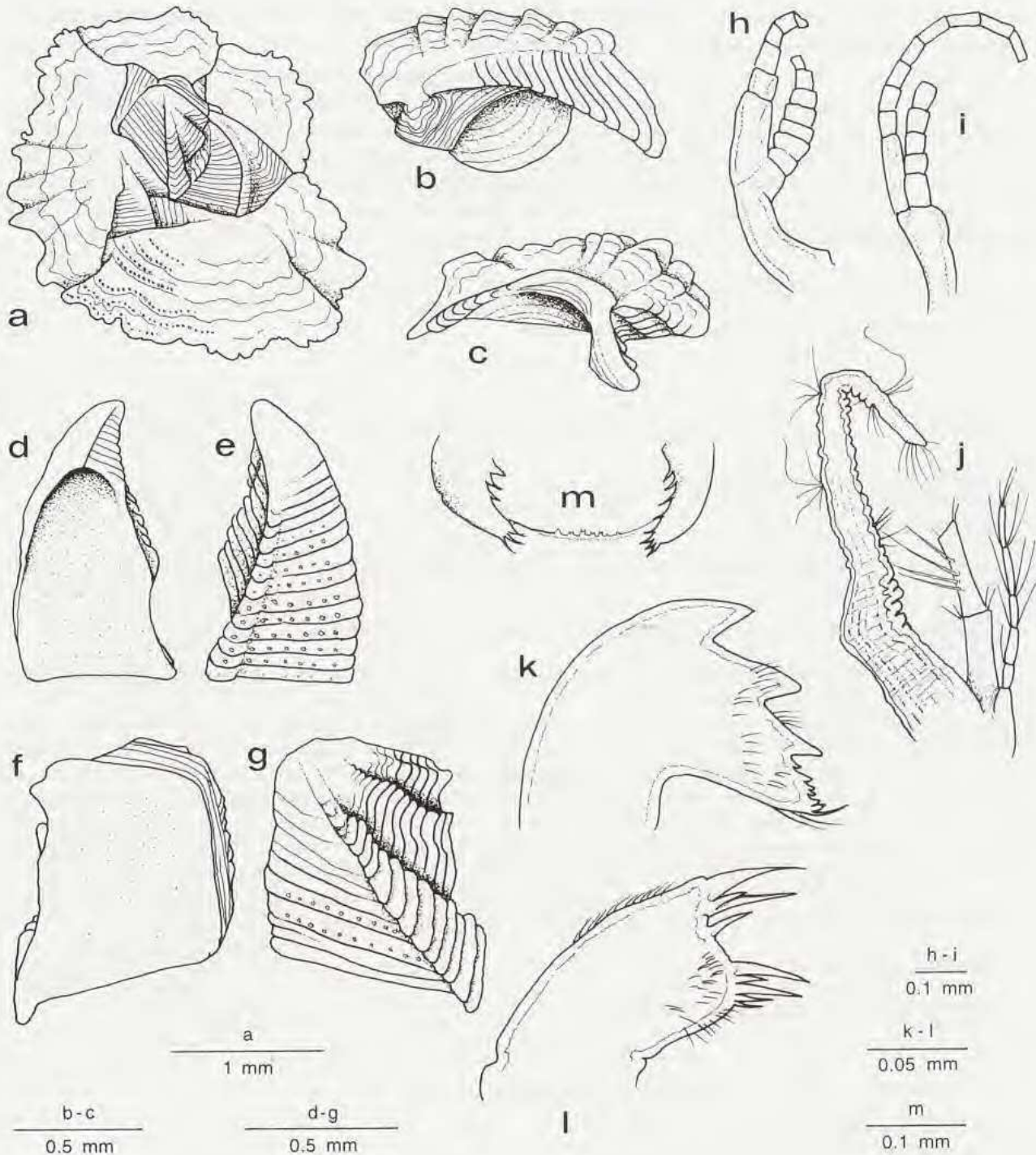


FIG. 1. — *Verruca jago* sp. nov.: **a**, holotype, complete shell (dorsal view), MNHN-Ci 2425; **b**, fixed scutum (right, dorsal view), showing lunulitiform myophore for adductor muscle attachment; **c**, fixed tergum (right, dorsal view), showing internal ledge for muscle attachment; **d**, movable scutum (left, interior); **e**, movable scutum (left, exterior); **f**, movable tergum (left, interior); **g**, movable tergum (left exterior); **h**, cirrus I; **i**, cirrus II; **j**, basal portion of cirrus VI, with penis and caudal appendage attached; **k**, mandible; **l**, first maxilla; **m**, labrum with palps. All material from 11°51'S, 43°20'E.

Specimen Ci 2426 still retains a small fragment of substrate, which appears to be an unweathered, fine grained, intermediate siliceous volcanic rock.

V. jago sp. nov. falls within a group of "shallow water" verrucids, including *V. cookei*, *V. laevigata*, *V. spengleri* and *V. stroemia*. *V. jago* may be distinguished from *V. stroemia* by its weaker external ribbing, a less projecting lower lobe on the first maxilla, a labrum with bidentate teeth and well separated palps. It differs from *V. cookei* by having a weakly hirsute central portion on the first maxilla, and much shorter caudal appendages. In *V. jago* the movable opercula are much narrower and the shell is more plicate than in *V. laevigata*. The movable scutum of *V. spengleri* is quite distinct, being both narrower, and possessing a more deeply excavated adductor muscle pit.

ETYMOLOGY. — An acronym for the submersible used during the expedition: *JAGO*.

DISTRIBUTION. — Grande-Comore Island, 196-203 m.

Genus *ALTIVERRUCA* Pilsbry, 1916

Verruca "Section D": *Altiverruca* Pilsbry, 1916: 40.

Verruca (*Altiverruca*) - FOSTER, 1978: 68.

Altiverruca - ZEVINA, 1987: 1813.

DIAGNOSIS. — Verrucids with erect form, bases of plates not inflected; operculum close to vertical; myophore absent.

TYPE SPECIES. — *Verruca hoeki* Pilsbry, 1907: 113. West Indies, 907-1060 m.

SPECIES. — The 37 taxa presently assigned to this genus include: *Altiverruca angustiterga* Zevina, 1987; *A. aves* (Zevina, 1975); *A. bicornuta* (Pilsbry, 1916); *A. beringiana* Zevina, 1992; *A. cassis* (Hoek, 1913); *A. casula* (Hoek, 1913); *A. crenata* (Aurivillius, 1898); *A. cristallina* (Gruvel, 1907); *A. cristallina laevis* (Broch, 1922); *A. darwini* (Pilsbry, 1907); *A. erecta* (Gruvel, 1900); *A. galapagosa* Zevina, 1987; *A. galkini* Zevina, 1990; *A. gibbosa* (Hoek, 1883); *A. gibbosa somaliensis* (Nilsson-Cantell, 1929); *A. gira* (Zevina, 1987); *A. hoeki* (Pilsbry, 1907); *A. incerta* (Hoek, 1883); *A. laeviscuta* Buckeridge, 1994; *A. longa* Zevina, 1988; *A. longicarinata* (Gruvel, 1900); *A. mitra* (Hoek, 1907); *A. mollae* Zevina, 1990; *A. navicula* (Hoek, 1913); *A. nitida* (Hoek, 1883); *A. obliqua* (Hoek, 1883); *A. plana* (Gruvel, 1907); *A. quadrangularis* (Hoek, 1883); *A. radiata* (Gruvel, 1901); *A. rathburniana* (Pilsbry, 1916); *A. sculpturata* Zevina, 1987; *A. sublima* Zevina, 1987; *A. sulcata* (Hoek, 1883); *A. tchesunovi* Zevina, 1988; *A. vitrea* Zevina, 1988; *A. vertica* Foster & Buckeridge, 1995; plus the new species described here: *A. jonesae* sp. nov.

STRATIGRAPHIC RANGE. — Recent.

DISTRIBUTION. — Cosmopolitan, 233-4950 m.

Altiverruca cristallina (Gruvel, 1907)

Verruca cristallina Gruvel, 1907, pl. 1, figs 9-10.

Verruca cristallina laevis Broch, 1922, fig. 41 a-d.

Verruca (*Altiverruca*) *cristallina* - ROSELL, 1989: 24, pl. 6, figs d-i. — ROSELL, 1991: 34.

Altiverruca cristallina - BUCKERIDGE, 1994: 93, figs 2a-h.

MATERIAL EXAMINED. — **Vanuatu**. MUSORSTOM 8: stn CP 1109, 14°52'S, 167°18'E, 1550-1620 m, 8.10.1994: 21 specimens, on rocks. — Stn CP 1110, 14°49'S, 167°15'E, 1360 m, 8.10.1994: 3 specimens, on rock.

DIAGNOSIS. — *Altiverruca* with carina and rostrum interlocking with up to 6 ribs; movable tergum with 4 to 5 articulating ribs, at least two articulating with scutum; caudal appendages short.

DISCUSSION. — This material conforms to that described in BUCKERIDGE (1994). This collection has extended the known geographic range for this species to Vanuatu waters.

DISTRIBUTION. — Tropical Pacific, 233-2340 m.

Altiverruca jonesae sp. nov.

Figs 2 a-f, 3 a-g.

MATERIAL EXAMINED. — Vanuatu. MUSORSTOM 8: Stn CP 1111, 14°51'S, 167°14'E, 1210-1250 m, 8.10.1994; 1 specimen, on an hexactinellid sponge.

TYPE. — *Holotype*: MNHN-Ci 2430, rostro-carinal diameter: 7.1 mm; height: 7.7 mm (from Stn CP 1111, 14°51'S, 167°14'E).

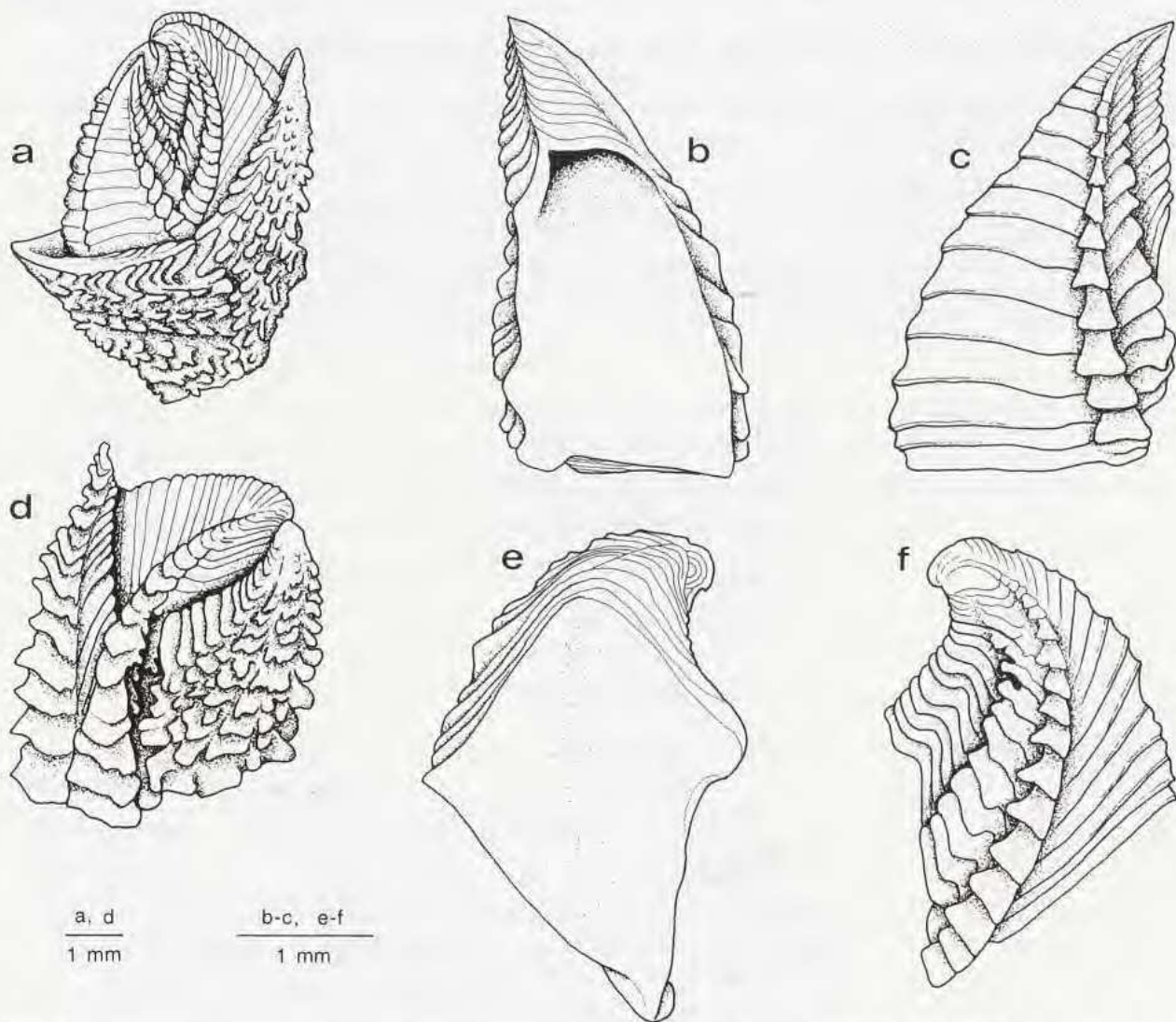


FIG. 2. — *Altiverruca jonesae* sp. nov.: a, holotype, complete shell (dorsal view), MNHN-Ci 2430; b, movable scutum (right, interior); c, movable scutum (right, exterior); d, complete shell (fixed opercula view); e, movable tergum (right, interior); f, movable tergum (right exterior). All material from Stn CP 1111.

DIAGNOSIS. — Moderate sized *Altiverruca* with surface ornamented by short rounded spines; movable tergum and scutum possessing 3 diagonal ribs; movable tergum with concave occludent margin and incurved apex.

DESCRIPTION. — Shell white, with short, flattened and rounded spines aligned along regularly spaced growth lines; rostrum and carina interlock with 4 to 5 ribs; apex of rostrum and carina produced.

Fixed scutum and fixed tergum with apices extending beyond opercular plates; fixed scutum folded over on upper margin to form surface confluent with plane of operculum; fixed tergum strongly flexed towards fixed scutum, with strong, sharply rounded primary diagonal rib, and weak minor secondary rib running along lower part of scutal margin.

Movable scutum triangular, apico-basal ridge prominent, with 2 secondary ribs, tergal margin concave; interior with elevated, well developed depression for adductor muscle attachment. Movable tergum with concave occludent margin and incurved apex; upper angle between occludent margin and scutal margin protuberant; 1 primary apico-basal ridge and 2 secondary ribs present on scutal side, carinal side without ribs.

Mandible tridentate, lower angle pectinate with 6 small spines; first maxilla with 1 large and 1 small upper spine, notch with 3 very small spines, lower angle with 1 large spine and 2 smaller spines, hirsute; labrum broadly arched, finely denticulate along entire margin, palps narrow, clearly separated across labrum.

Cirri I and II with anterior rami approximately half length of posterior, cirrus III more like cirrus IV than II; penis thin with terminal setae. Cirri with following number of segments, where cirri are incomplete, maximum for both sides considered (r-c being rostro-carinal diameter) :

r-c (mm)	I	II	III	IV	V	VI	c.a.
7.1	7, 10	7, 12	19, 23	19+, 25	21+, 23+	25+, 28+	8

Intermediate segments of cirrus VI with 2 pairs of setae, distal pair much larger than proximal; length of caudal appendages approximately 1.2x length of basal segment of pedicel of cirrus VI.

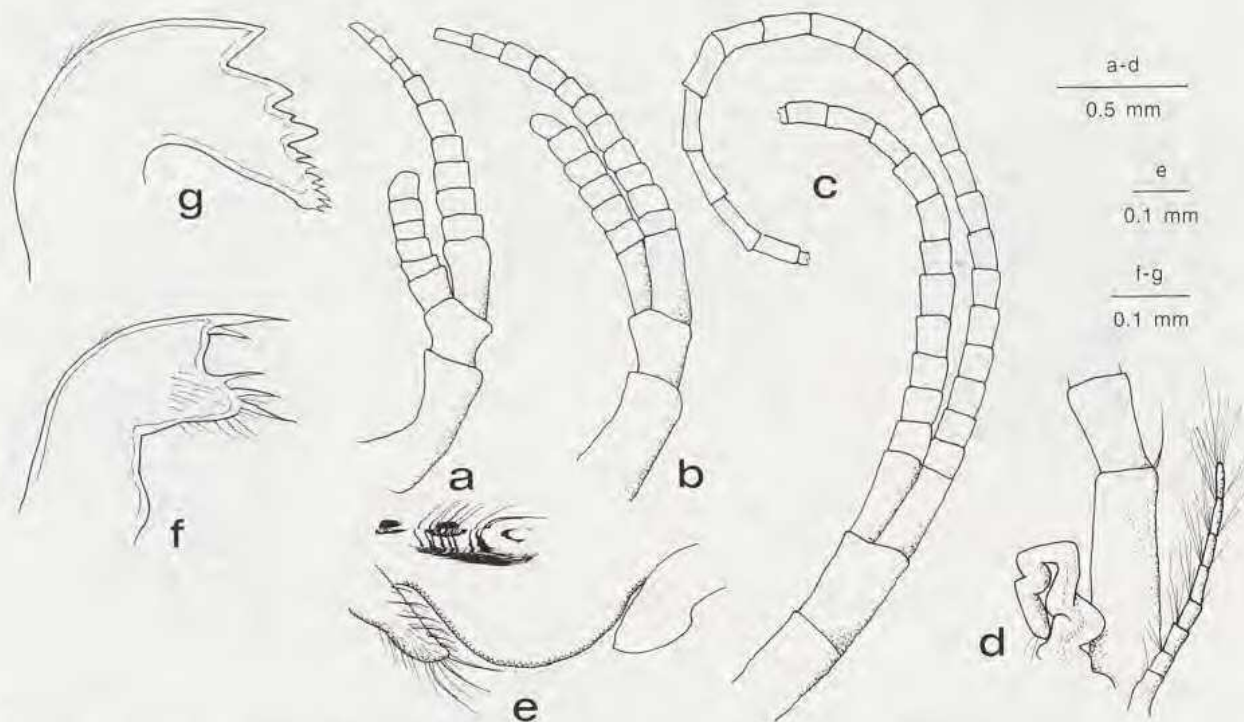


FIG. 3. — *Altiverruca jonesae* sp. nov.: a, holotype, cirrus I, MNHN-Ci 2430; b, cirrus II; c, cirrus III; d, basal portion of cirrus VI, with penis and caudal appendage attached; e, labrum with palps, setae shown on left palp only; f, first maxilla; g, mandible. All material from Stn CP 1111.

DISCUSSION. — This is a most elegant species. Unfortunately only one specimen has been collected; however the spinose nature of the shell ornamentation, the deep adductor muscle depression on the movable scutum and the strongly incurved apex and shape of the movable tergum are sufficient to warrant specific differentiation. Shell ornamentation is considered significant with this species, as this is clearly neither a function of substrate nor overcrowding. *Verruca jonesae* resembles, but may be distinguished from, both *Altierruca gibbosa* (Hoek, 1883), and *Altierruca sulcata* (Hoek, 1883), by the ornate ornamentation, a more defined second rib on the movable scutum, the incurved apex of the movable tergum and a much shorter anterior ramus on cirrus I.

It may be distinguished from a similar north Pacific species, *Altierruca sculpturata* Zevina 1987, by a narrower movable scutum, a more protruded fixed tergal apex, and more spinose shell ornamentation.

ETYMOLOGY. — Named for Diana JONES, Curator of Crustacea, Western Australian Museum, in recognition of her extensive work with the cirripedes of the region.

DISTRIBUTION. — Vanuatu, 1210-1250 m.

Altierruca nitida (Hoek, 1883)

Fig 8 a-b.

Verruca nitida Hoek, 1883: 138, figs 6-7. — GRUVEL, 1905: 177, fig. 194. — NILSSON-CANTELL, 1927: 778.
Altierruca nitida - BUCKERIDGE, 1994: 101, fig 6 a-g.

MATERIAL EXAMINED. — **New Caledonia**. BIOCAL: stn CP 29, 23°08'S, 166°40'E, 1100 m, 29.8.1985: 5 specimens, on pebbles. — Stn CP 30, 23°09'S, 166°41'E, 1140 m, 9.8.1985: 6 specimens, on pebbles, shell. — Stn DW 51, 23°05'S, 167°44'E, 700 m, 31.8.1985: 1 specimen.

BATHUS 1: stn CP 651, 21°41'S, 166°40'E, 1080-1180 m, 11.3.1993: 1 specimen.

Vanuatu. MUSORSTOM 8: stn CP 1074, 15°48'S, 167°24'E, 775-798 m, 4.10.1994: 1 specimen, on scaphopod shell. — Stn CP 1125, 15°57'S, 166°38'E, 1160-1220 m, 10.10.1994: 4 specimens, on pebbles. — Stn CP 1129, 16°00'S, 166°39'E, 1014-1050 m, 10.10.1994: 8 specimens on pebbles.

DIAGNOSIS. — *Altierruca* with carina and rostrum interlocking with 2 ribs; movable scutum with 2 ribs articulating with 1 strong diagonal rib of movable tergum; caudal appendages long.

DISCUSSION. — This material conforms to that described in BUCKERIDGE (1994). The specimen from station CP 1074 has a less flared shell than most, but this is attributed to the substrate.

DISTRIBUTION. — Tropical western Pacific, 650 to 2040 m.

Genus *BROCHIVERRUCA* Zevina, 1993

DIAGNOSIS. — Verrucids with apex (umbo) of both carina and rostrum removed from margin of plates; fixed scutum with or without myophore.

TYPE SPECIES. — *Brochiverruca margulisiae* Zevina, 1993: 10. Mozambique Channel, Indian Ocean, 935-950 m.

SPECIES. — Four species are here assigned to this genus: *Brochiverruca margulisiae* Zevina, 1993; *B. dens* (Broch, 1932); *B. polystriata* Buckeridge, 1994; and the new species described here: *B. crosnieri* sp. nov.

STRATIGRAPHIC RANGE. — Recent.

DISTRIBUTION. — Western Pacific and Western Indian Ocean, 270-950 m.

DISCUSSION. — The distinctive nature of *Brochiverruca* was first recognised by BROCH (1932). He suggested that the patelliform carina might be sufficient cause to set *V. dens* apart from *Rostratoverruca*. However, he left

this "to future investigators to settle, whether *Verruca dens* must be considered type of a separate subgenus or not". In light of this reference, and the abundance of *V. dens*, it is to be regretted that ZEVINA chose not to use *Verruca* (*Rostratoverruca?*) *dens* as her type.

Brochiverruca crosnieri sp. nov. extends the bathymetric range of the genus into shallower water. Prior to this record, the genus was unknown from depths of less than 348 m. *Brochiverruca* is unlike other verrucids in that the species appear to have strong substrate (= host) preferences. Of the *Brochiverruca* species that I have studied, all are consistently attached to the following cnidarians:

<i>Brochiverruca dens</i> (Broch)	scleractinian	<i>Madrepora</i>
<i>Brochiverruca polystriata</i> Buckeridge	scleractinian	<i>Ellanospammia</i> and <i>Madrepora</i>
<i>Brochiverruca crosnieri</i> sp. nov.	antipatharian	antipatharian sp. indet.

Unfortunately, ZEVINA states only that the type, *B. margulisae* Zevina, represented by 4 specimens, is attached to "coral".

Brochiverruca crosnieri sp. nov.

Fig 4 a-h

MATERIAL EXAMINED. — **Loyalty Ridge**. MUSORSTOM 6; stn CP 401, 20°42'S, 167°00'E, 270 m, 14.2.1989: 1 specimen, on antipatharian.

TYPE. — *Holotype*: MNHN-Ci 2424, r-c diameter: 2.2 mm; height: 2.4 mm (from Stn CP 401, 20°42'S, 167°00'E).

DIAGNOSIS. — Shell white, porcelanous, very finely sculptured with delicate longitudinal striae crossed by fine growth lines; rostrum and carina each with apex separated from upper margin by slightly more than 1/3rd distance from basal margin; interior of movable tergum with articular node on scutal margin; fixed scutum with ledge for adductor muscle attachment.

DESCRIPTION. — Shell white, porcelanous, molariform; exterior very finely sculptured, with delicate longitudinal striae crossed by fine growth lines.

Rostrum and carina each with apex protruded and incurved distally, separated from upper margin by slightly more than one third distance from basal margin; margin between both plates characterised by 5 flat and non-prominent, articulating ribs.

Fixed scutum with ledge internally for adductor muscle attachment; fixed tergal edge confluent with fixed tergum and with no clear articulating ribs, fixed tergal apex most elevated part of shell.

Movable tergum of low relief, quadrangular, with 1 narrow, flat medial rib; with extended upper angle of articular margin articulating with movable scutum; internally with articular node on scutal margin.

Movable scutum quadrangular, less than half width of movable tergum, with weak apico-basal ridge; apex incurved towards movable tergum; interior with raised central portion excavated centrally for adductor muscle attachment; tergal margin of raised area with rounded embayment (fig. 4b).

Mandible tridentate, lower angle pectinate with about 7 small spines; first maxilla with 2 larger spines above notch and 3 spines on lower part, centrally hirsute, 3 tufts of setae on upper surface. Labrum gently arcuate, margin finely denticulate. Penis about twice length of caudal appendages, terminally hirsute. Cirri I and II with flattened anterior rami, cirrus III more like cirrus IV than II; intermediate segments of cirrus VI with 3 pairs of setae. Cirri with following number of segments, (r-c being rostro-carinal diameter) :

r-c (mm)	I	II	III	IV	V	VI	c.a.
2.2	6, 8	5, 10	14, 16	9+, 17	16, 16+	17, 23	5

Caudal appendages about half as long as basal segment of pedicel of cirrus VI.

DISCUSSION. — This species is related to *Brochiverruca dens* (Broch) and *Brochiverruca polystriata* Buckeridge. It may be distinguished from *B. dens* by its significantly smoother shell, with longitudinal ornamentation

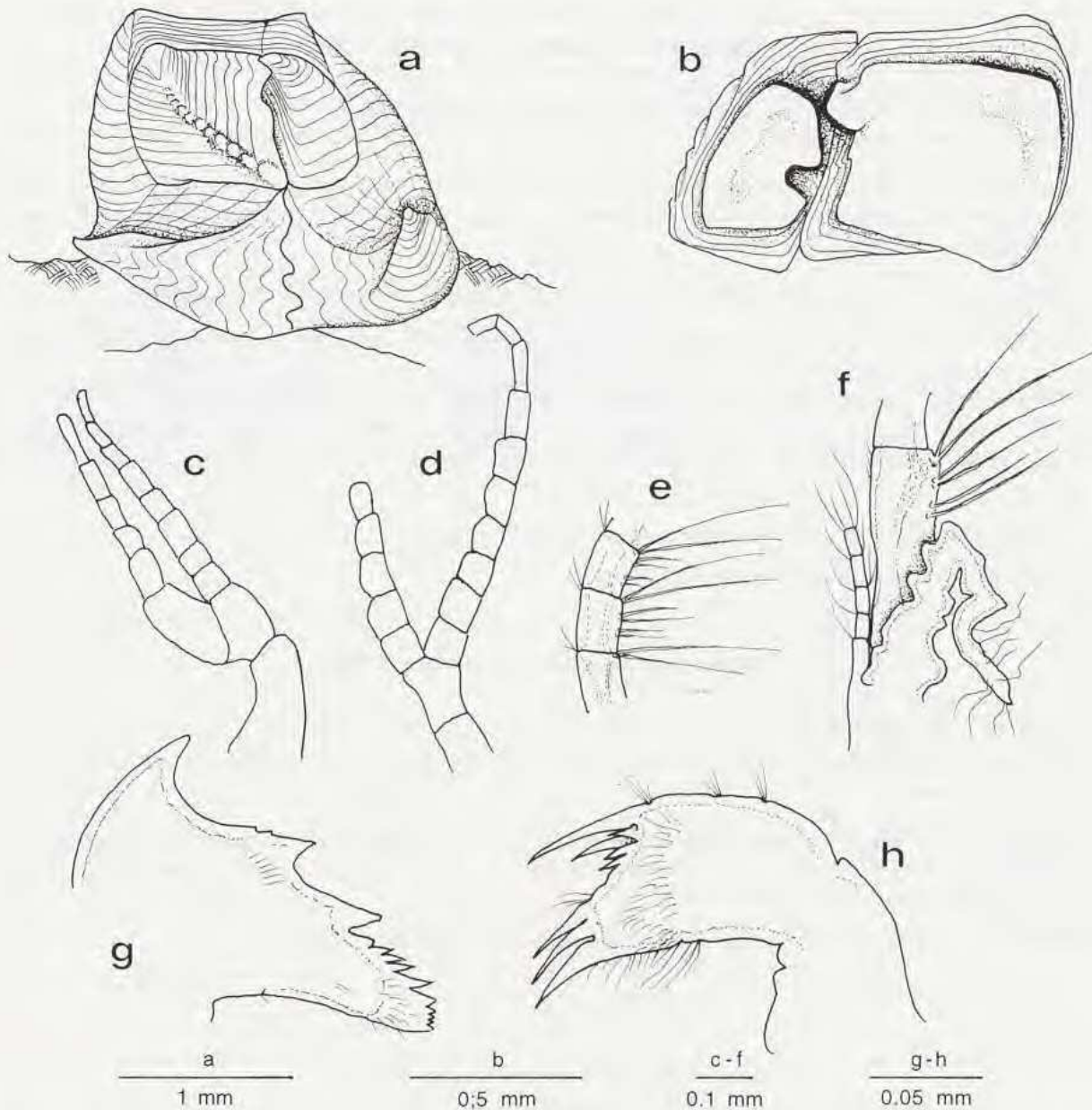


FIG. 4. — *Brochiverruca crosnieri* sp. nov.: a, holotype, complete shell (dorsal view), MNHN-Ci 2424; b, movable scutum and movable tergum (interior); c, cirrus I; d, cirrus II; e, intermediate segment of cirrus VI; f, basal portion of cirrus VI, with penis and caudal appendage attached; g, mandible; h, first maxilla. All material from Stn CP 401.

restricted to rare striae; and a broader movable scutum and finely denticulate labrum. It differs from *B. polystriata* in its shell ornamentation, and the possession of only one rib on the movable tergum.

ETYMOLOGY. — Named for Alain CROSNIER, ORSTOM (Institut Français de Recherche Scientifique pour le Développement en Coopération), Paris, who was instrumental in much of the collecting and sorting, and who provided sustained support and friendship during my sojourn in Paris.

DISTRIBUTION. — Loyalty Ridge, 270 m.

Genus *METAVERRUCA* Pilsbry, 1916

Verruca "Section A": *Metaverruca* Pilsbry, 1916: 21.

Verruca (Metaverruca) - NEWMAN, ZULLO & WITHERS, 1969: R283. — FOSTER, 1978: 68.

Metaverruca - ZEVINA, 1987: 1812.

DIAGNOSIS (Amended). — Verrucids with box-like shell; apices of carina and rostrum marginal; fixed scutum with myophore; operculum parallel to base, with straight basal margin, such that aperture is "D-shaped"; base of shell wall inflected internally, thickened.

TYPE SPECIES. — *Verruca recta* Aurivillius, 1898: 195 (Subsequent Designation). The Azores, 1135 m.

SPECIES. — Thirteen species are presently assigned to this genus: *Metaverruca corrugata* (Broch, 1922); *M. defayeeae* Buckeridge, 1994; *M. lepista* (Zevina, 1987); *M. macani* (Stubbings, 1936); *M. norfolkensis* Buckeridge, 1994; *M. pacifica* Buckeridge, 1994; *M. pallida* Zevina, 1990; *M. plicata* Buckeridge, 1994; *M. recta* (Aurivillius, 1898) (for full synonymy and comments see BUCKERIDGE, 1994); *M. reunioni* Foster & Buckeridge, 1995; *M. seriola* (Zevina, 1987); *M. tarasovi* Zevina, 1971; plus the new species described here, *M. maclaughlinae* sp. nov.

STRATIGRAPHIC RANGE. — Lower Miocene (New Zealand) to Recent.

DISTRIBUTION. — Cosmopolitan, 167- 4100 m.

Metaverruca defayeeae Buckeridge, 1994

Metaverruca defayeeae Buckeridge, 1994: 109, fig. 19 a-g.

MATERIAL EXAMINED. — **Vanuatu**. MUSORSTOM 8: stn DW 989, 19°13'S, 169°20'E, 650-669 m, 23.9.94: 2 specimens, on rock.

DIAGNOSIS. — A large *Metaverruca* with movable tergum and scutum having 4 articular ribs; exterior smooth with closely spaced growth lines; mandible quinquedentate, caudal appendages short, less than length of basal segment of pedicel of cirrus VI.

DISCUSSION. — This material conforms to that described by BUCKERIDGE (1994).

DISTRIBUTION. — Western Pacific, 370-710 m.

Metaverruca macani (Stubbings, 1936)

Fig 5 a-i.

Verruca macani Stubbings, 1936: 39, figs 17 a-b.

MATERIAL EXAMINED. — **Zanzibar**. JOHN MURRAY EXPEDITION 1933-1934: stn 122, 05°22'S, 39°23'E, 762 m, 1935: 1 specimen, slightly damaged.

TYPE. — *Holotype*: Natural History Museum (London) Cat. No. NHM 1938.1.20.154, (unique specimen).

DIAGNOSIS (Amended). — *Metaverruca* with movable tergum quadrangular, movable scutum and tergum each with 4 articular ridges; caudal appendages short.

DESCRIPTION (Amended and updated to include internal anatomy). — Medium sized *Metaverruca* with shell white, low conic, sides steep; operculum sub-parallel to base; exterior generally smooth, with relatively closely spaced concentric growth lines; rostrum and carina articulating with 3 ribs; basis membranous. Fixed scutum with

well formed myophore for adductor muscle attachment; movable tergum quadrangular, with well defined apico-basal rib, plus 3 secondary ribs, interlocking with movable scutum; articular margin slightly concave; movable scutum triangular, with 3 ribs interlocking with tergum and further adjacent curved, apico-basal rib terminating at rostro-carinal suture; occludent portion lacking ribbing; internally with elevated and well formed depression for adductor muscle attachment; both opercular plates together form almost straight rostro-carinal hinge.

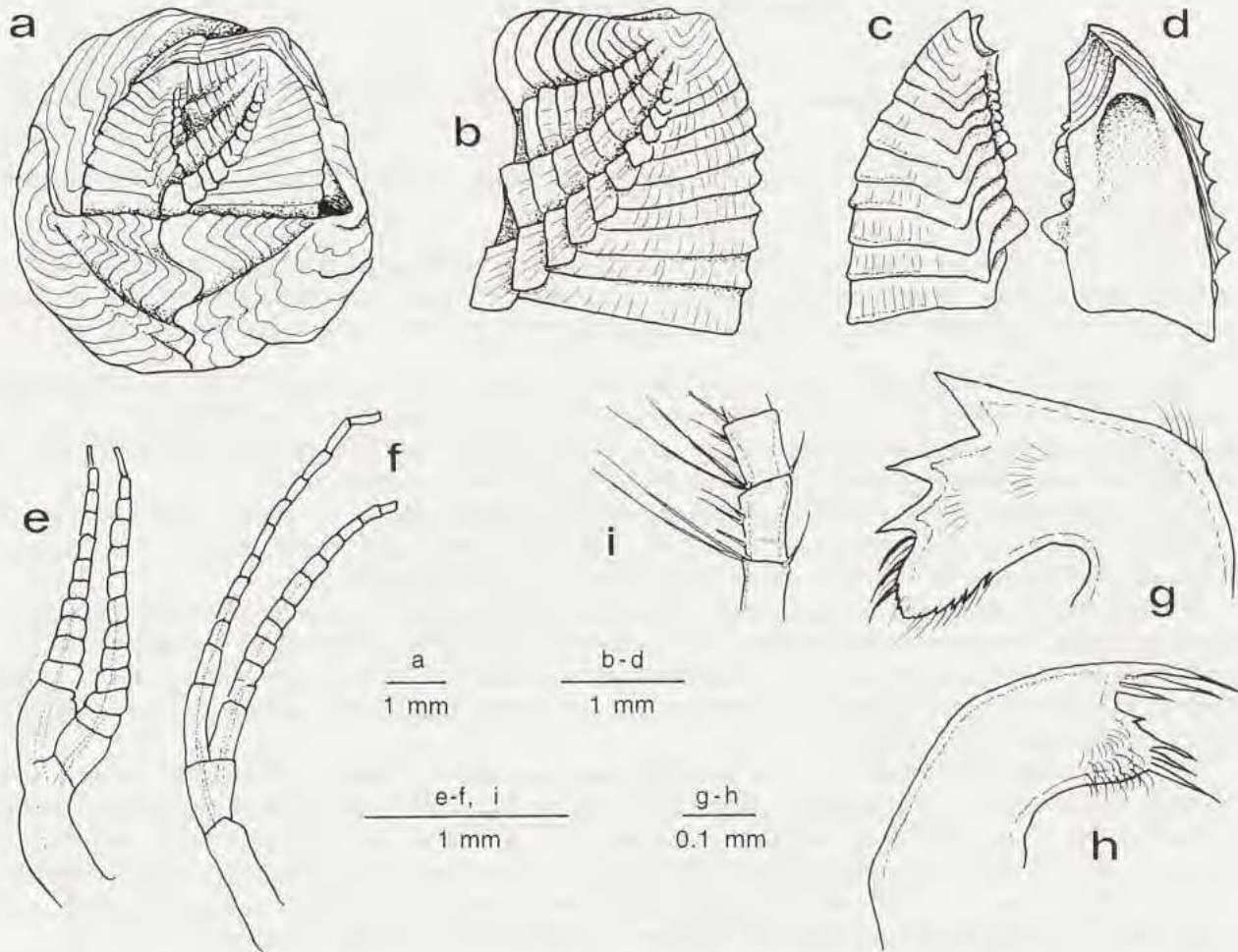


FIG. 5. — *Metaverruca macani* (Stubbings, 1936): a, holotype, complete shell (dorsal view), BM(NH) Cat. No. 1938.1.20.154; b, movable tergum (right, exterior); c, movable scutum (right, exterior); d, movable scutum (right, interior); e, cirrus I; f, cirrus II; g, mandible; h, first maxilla; i, intermediate segment of cirrus VI. All material from Stn 122.

Mandible tridentate, lower angle pectinate; first maxilla with 2 large upper spines, moderate notch with 1 small spine, lower angle hirsute, with 4 large spines.

Cirri possess the following number of segments (r-c being the rostro-carinal diameter) :

r-c (mm)	I	II	III	IV	V	VI	c.a.
6.4	13,12	12,12	18,18	24,26	24,28	35,36	7
	13,15	13,14					

Counts for cirri I and II for both sides of animal.

Caudal appendages very short, length less than that of basal segment of pedicel of cirrus VI; penis short.

DISCUSSION. — *Metaverruca macani* has not been recorded since the original collection made by the John Murray Expedition. This species shows some similarity to *Metaverruca pacifica* Buckeridge. Comments on the differences between the two species are provided here-in, under the discussion of that species.

DISTRIBUTION. — Off Zanzibar, 726 m.

Metaverruca maclaughlinae sp. nov.

Fig 6 a-k.

MATERIAL EXAMINED. — Vanuatu. MUSORSTOM 8: stn CP 1080, 15°57'S, 167°27'E, 799-850 m, 5.10.1994: 1 specimen, on scaphopod shell.

TYPE. — *Holotype*: MNHN-Ci 2429, r-c diameter: 6.7 mm; height: 2.9 mm (1 specimen, from Stn CP 1080, 15°57'S, 167°27'E).

DIAGNOSIS. — Medium *Metaverruca* with moderately rugose external ribbing; movable tergum and scutum each having 4 articular ribs; cirrus I with sub equal rami, cirrus II with anterior ramus less than half length of posterior; caudal appendages almost 4 times that of basal segment of pedicel of cirrus VI; penis vestigial.

DESCRIPTION. — Medium sized *Metaverruca* with shell white, moderate to low conic, sides steep; operculum sub-parallel to base, orifice D-shaped; exterior characterised by rugose, irregular, vertical ribbing, with relatively closely spaced concentric growth lines and ridges, secondary ribs develop in interstices of primary ribs as shell diameter increases; rostrum and carina each articulating with 3 ribs; basis membranous.

Fixed scutum quadrangular, with large, tongue-shaped myophore for adductor muscle attachment; articulating with fixed tergum with 1 rib and with rostrum with 2 ribs; fixed tergum of similar width to fixed scutum, articulating with carina with 1 rib; basal margin of shell slightly thickened and inflected.

Movable tergum quadrangular, having well defined apico-basal rib, and 3 secondary ribs, interlocking with movable scutum; movable scutum triangular, with 3 ribs interlocking with tergum and further adjacent curved, apico-basal rib terminating and protruding slightly at rostro-carinal suture; internally with moderately weak depression for adductor muscle attachment developed close to occludent margin; both opercular plates together form almost straight rostro-carinal hinge.

Mandible tridentate, lower angle pectinate, with 5 stout spines and numerous small setae; first maxilla with 2 prominent upper spines and 1 smaller adjacent spine, lower angle with 4 long and 2 shorter spines. Labrum moderately deeply arched, basally slightly protuberant, denticulate along entire margin, palps well spaced, moderately sharp; cirrus I with subequal rami, cirrus II with anterior ramus less than half length of posterior; intermediate segments of cirrus VI with long upper, medium middle and very small lower pairs of setae.

Holotype cirri possess following number of segments (r-c being the rostro-carinal diameter) :

r-c (mm)	I	II	III	IV	V	VI	c.a.
6.7	15,17	9,18	18,21	26,29	28,30	30,29	23

Caudal appendages very long, almost 4 times that of basal segment of pedicel of cirrus VI; penis vestigial.

DISCUSSION. — When first observed, *Metaverruca maclaughlinae* appeared similar to *Metaverruca defayae*; with the primary external difference, a rugose surface, being attributed to the type of substrate. The growth of this verrucid was indeed tortuous, as the diameter of the specimen exceeded that of the scaphopod shell on which it grew, such that the resulting exposed base required to be sealed with sand grains. However, *M. maclaughlinae* has quite distinctive internal anatomy, the caudal appendages are proportionately longer than in any other known *Metaverruca*, and the cirri are also unusual, with cirrus I being longer than cirrus II.

Metaverruca maclaughlinae may be distinguished from *Metaverruca pacifica* Buckeridge by its movable tergum, which possesses a longer occludent margin, the movable scutum, which lacks longitudinal striae or ribs on the occludent side, the shorter anterior ramus of cirrus II and the presence of spines in the notch of the first maxilla. It

differs from *M. defayae* primarily by its more rugose external ornamentation and the very much longer caudal appendages.

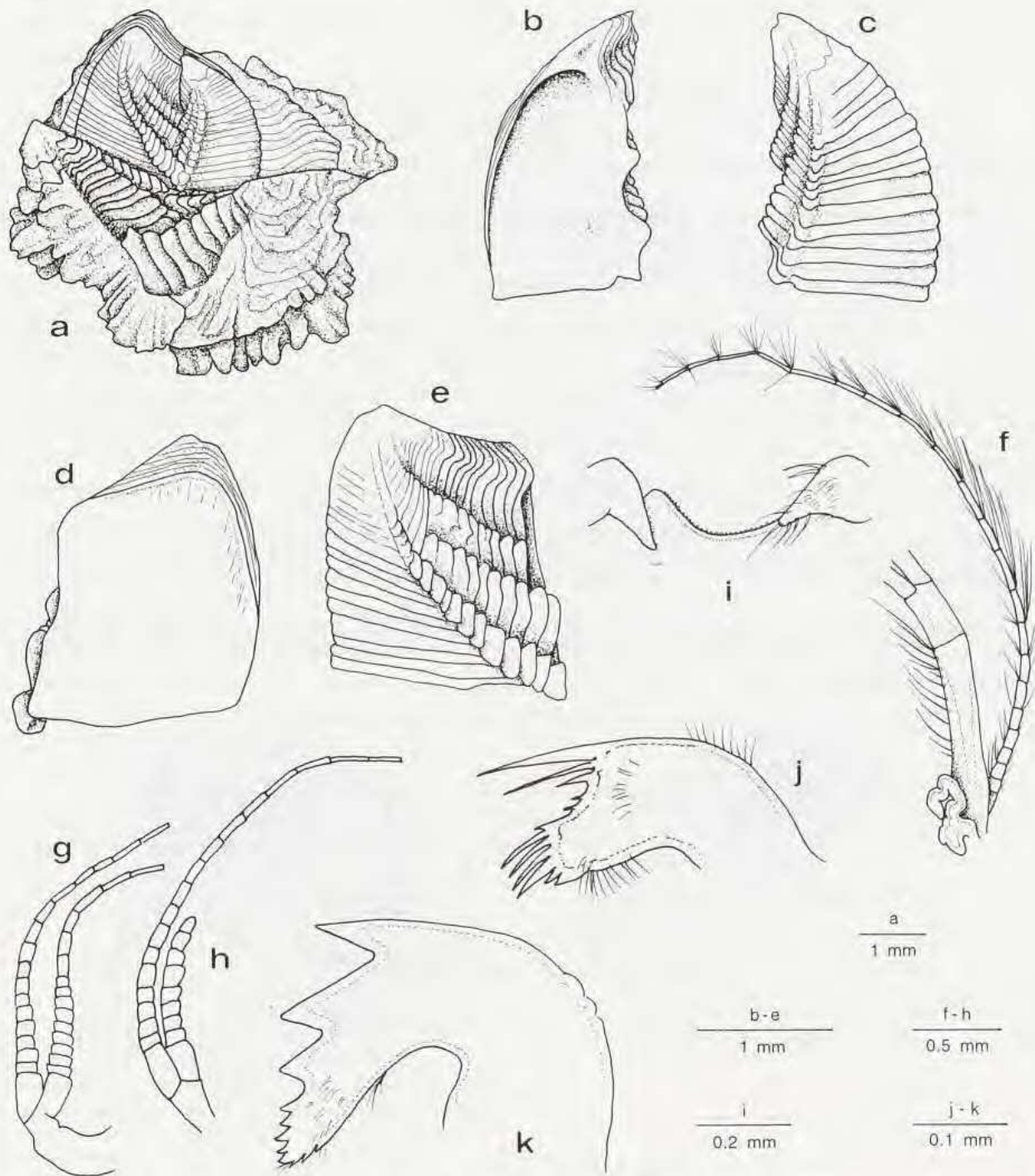


FIG. 6. — *Metaverruca maclaughlinae* sp. nov.: a, holotype, complete shell (dorsal view), MNHN-Ci 2429; b, movable scutum (left, interior); c, movable scutum (left, exterior); d, movable tergum (left, interior); e, movable tergum (left exterior); f, basal portion of cirrus VI, with penis and caudal appendage attached; g, cirrus I; h, cirrus II; i, labrum with palps, setae shown on right palp only; j, first maxilla; k, mandible. All material from Stn CP 1080.

ETYMOLOGY. — Named for Dr Patsy McLAUGHLIN, Sedro Woolley, Washington, United States of America, in recognition of her previous work on cirripedes, and her support and knowledge during my Paris sojourn.

DISTRIBUTION. — Vanuatu, 799-850 m.

Metaverruca pacifica Buckeridge, 1994

Fig 7 a.

Metaverruca pacifica Buckeridge, 1994: 112, figs 11 a-g, 16 c-d.

MATERIAL EXAMINED. — **New Caledonia.** MUSORSTOM 6: stn DW 485, 21°23'S, 167°59'E, 346-360 m, 23.2.1989: 1 specimen on a stylasterine coral.

BATHUS 1: stn CP 663, 20°58'S, 165°38'E, 730-780 m, 13.3.1993: 3 specimens, on pumice. — Stn CP 708, 21°43'S, 166°38'E, 550-580 m, 19.3.1993: 1 specimen, on gastropod. — Stn CP 709, 21°41'S, 166°37'E, 650-800 m, 19.3.1993: 8 specimens, on pumice.

BATHUS 2: stn CP 743, 22°35'S, 166°26'E, 713-950 m, 14.5.1993: 3 specimens, on pumice. — Stn CP 755, 22°21'S, 166°13'E, 495 m, 16.5.1993: 3 specimens, on basalt. — Stn CP 771, 22°09'S, 166°01'E, 610-800 m, 18.5.1993: 1 specimen, on a daphnelline gastropod.

BATHUS 3: stn CP 832, 23°03'S, 166°53'E, 650-669 m, 30.11.1993: 13 specimens, on pumice. — Stn CP 850, 21°43'S, 166°39'E, 541-580 m, 19.3.1994: 1 specimen, on pumice. — Stn DW 776, 24°44'S, 170°08'E, 770-830 m, 24.11.1993: 2 specimens, on a gastropod. — Stn CP 821, 23°19'S, 167°58'E, 864-880 m, 29.11.1993: 1 specimen, on a gastropod.

HALIPRO 1: stn CP 854, 21°40'S, 166°38'E, 650-780 m, 19.3.1994: 7 specimens, on pebbles and a gastropod. — Stn CP 867, 21°26'S, 166°18'E, 720-950 m, 22.3.1994: 4 specimens, on a gastropod.

BATHUS 4: stn CP 913, 18°08'S, 163°86'E, 777-820 m, 5.8.1994: 5 specimens, on a gastropod shell and detritus.

Loyalty Ridge. MUSORSTOM 6: stn CP 467, 21°05'S, 167°32'E, 575 m, 21.2.1989: 1 specimen.

Wallis-Futuna. MUSORSTOM 7: stn CP 622, 12°34'S, 178°11'W, 1280-1300 m, 28.5.1992: 1 specimen, on a cidaroid spine.

NW Australia. "Soela": stn 6-84, 18°43'S, 166°35'E, 610-612 m, 7.4.1982: 1 specimen, on a scalpellid. — Stn 1001-86, 18°43'S, 116°35'E, 600 m, 7.4.1982: 2 specimens. — Stn 253-95, 18°00'S, 118°10'E, 436 m, 24.2.1984: 28 specimens, on a gastropod.

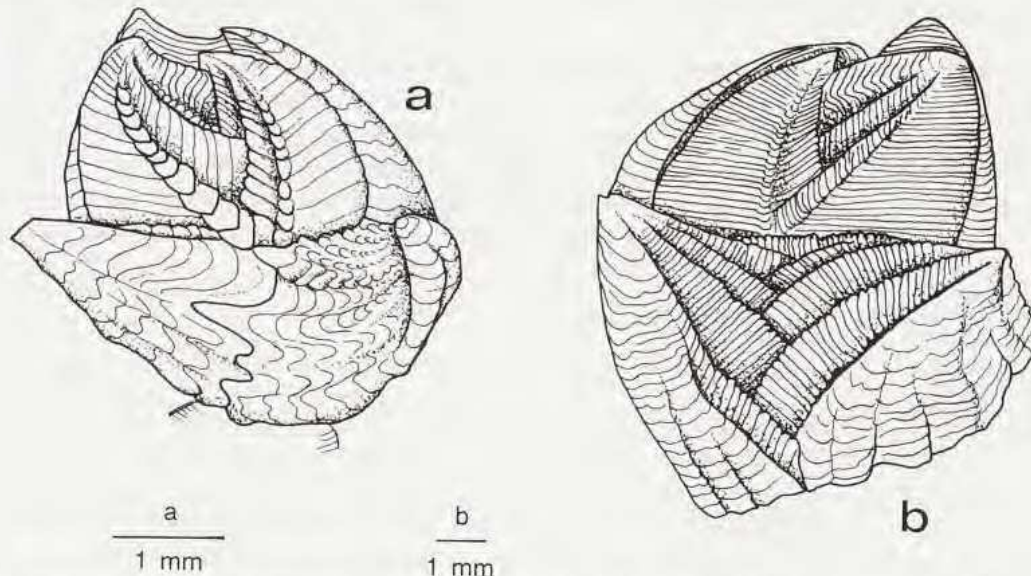


FIG. 7 a. — *Metaverruca pacifica* Buckeridge, 1994. Complete shell (dorsal view), variety, with distortion resulting from basal restriction following attachment to the apex of a gastropod. Material from Stn CP 821.

FIG. 7 b. — *Metaverruca recta* (Aurivillius, 1898). Complete shell (dorsal view), MNHN-Ci 2423, variety with moderately rugose exterior and close, well defined growth lines. Material from Stn CP 1125.

DIAGNOSIS. — *Metaverruca* with movable tergum and scutum having 4 articular ribs; exterior generally smooth with widely spaced growth lines; caudal appendages more than twice length of basal segment of pedicel of cirrus VI.

DISCUSSION. — The new material extends both the depth and geographic ranges of *M. pacifica* as provided in BUCKERIDGE (1994).

Since the original description of this species, I have reviewed the Verrucidae, and briefly considered that *Verruca macani* Stubbings, 1936 may be very similar to this species. Although there is only a single, incomplete specimen of *V. macani* known, I was able to view the type in the Natural History Museum, London, and concluded that the two species are quite distinct. On shell morphology alone, *V. macani* (here described as a *Metaverruca*), differs in having a more quadrangular movable tergum, the movable scutum lacks apico-basal ridges and the rostrum does not possess a distinct ribbed zone arcing back to the base of the movable scutum.

A number of specimens of *M. pacifica* have been recovered from gastropod shells inhabited by parapagurid hermit crabs (e.g. DW 776, CP 821, CP 867, CP 913). In most instances, *M. pacifica* is attached at the posterior of the gastropod shell, and with the somewhat restricted attachment site this provides, the verrucid is unusually contorted (figure 7a).

DISTRIBUTION. — From waters off New Caledonia, Loyalty Ridge, Wallis and Futuna Islands, north west Australia, 346-1300 m.

Metaverruca plicata Buckeridge, 1994

Metaverruca plicata Buckeridge, 1994: 114, fig. 12 a-i.

MATERIAL EXAMINED. — **New Caledonia.** BATHUS 3: stn DW 786, 23°54'S, 169°49'E, 699-715 m, 25.11.1993: 1 specimen, on a scleractinian.

Vanuatu. MUSORSTOM 8: stn DW 989, 19°13'S, 169°20'E, 650-669 m, 23.9.1994: 1 specimen, on rock. — Stn CP 1125, 15°57'S, 166°38'E, 1160-1220 m, 10.10.1994: 1 specimen, on pebble.

DIAGNOSIS. — A medium to large *Metaverruca* with strong external ribbing; movable tergum and scutum each having 3 articular ribs; movable scutum moderately narrow; caudal appendages long, about two and half times length of basal segment of pedicel of cirrus VI.

DISCUSSION. — These records extend the geographic distribution of *M. plicata* to the waters off New Caledonia and Vanuatu. The bathymetric range is doubled. A specimen from CP 1125 conforms to the holotype with the exception that it has slightly less well developed external ribbing.

DISTRIBUTION. — South west Pacific, 520-1220 m.

Metaverruca recta (Aurivillius, 1898)

Fig. 7 b.

Verruca recta Aurivillius, 1898: 195.

Verruca sculpta Aurivillius, 1898: 197.

Verruca linearis Gruvel, 1900: 243; 1902: 107, pl. 5 figs 11-12.

Verruca magna Gruvel, 1901: 261; 1902: 109, pl. 5 figs 1-2.

Verruca halotheca Pilsbry, 1907: 188, pl. 12 figs 9, 10.

Verruca capsula Hoek, 1913: 130, pl. 12 figs 1-3, pl. 13 figs 1-4.

Verruca coraliophila Pilsbry, 1916: 21, pl. 1 figs 1-5.

Verruca cookei - ROSELL, 1989: 299, pl. 11 figs r,s,u,v; 1991: 33. Non *Verruca cookei* Pilsbry, 1927.

Metaverruca recta - BUCKERIDGE, 1994: 116, fig 13 a-f.

MATERIAL EXAMINED. — **New Caledonia.** MUSORSTOM 5: stn DW 302, 22°10'S, 159°23'E, 346-360 m, 12.10.1986: 1 specimen, on a turritellid.

BATHUS 1: stn CP 651, 21°41'S, 166°40'E, 1080-1180 m, 11.3.1993: 1 specimen, on pumice. — Stn CP 660, 21°10'S, 165°53'E, 786-800 m, 13.3.1993: 3 specimens, on pumice.

BATHUS 2: stn DW 734, 23°00'S, 166°51'E, 766-775 m, 13.5.1993: 1 specimen, on pumice.

BATHUS 3: stn DW 778, 24°43'S, 170°07'E, 750-760 m, 24.11.1993: 1 specimen. — Stn CP 842, 23°05'S, 166°48'E, 830 m, 1.12.1993: 1 specimen, on pumice.

HALIPRO 1: stn CP 858, 21°42'S, 166°41'E, 1000-1120 m, 20.3.1994: 1 specimen, on shell fragment.

Indonesia. KARUBAR: stn DW14, 05°18'S, 132°38'E, 245-246 m, 24.10.1991: 1 specimen, on pebble.

Grande-Comore. JAGO-COELACANTHE: 11°51'S, 43°20'E, 203 m, 1.12.1989: 1 specimen.

Vanuatu. MUSORSTOM 8: stn CP 991, 18°51'S, 168°52'E, 936-910 m, 24.9.1994: 2 specimens, attached to pumice rock. — Stn CP 956, 20°33'S, 169°35'E, 1175-1210 m, 21.9.1994: 5 specimens, on pumice. — Stn DW 969, 20°18'S, 169°53'E, 252-280 m, 21.9.1994: 1 specimen, on a brachiopod. — Stn DW 977, 19°24'S, 169°28'E, 410-505 m, 22.9.1994: 2 specimens, on pebble. — Stn DW 986, 19°20'S, 169°31'E, 602-648 m, 23.9.1994: 3 specimens, on pebbles. — Stn CP 990, 18°51'S, 168°50'E, 980-990 m, 24.9.1994: 10 specimens, on pumice. — Stn CP 991, 18°51'S, 168°52'E, 936-910 m, 24.9.1994: 8 specimens, on rock. — Stn CP 1008, 18°53'S, 168°52'E, 919-1000 m, 25.9.1994: 3 specimens, on pumice. — Stn CP 1025, 17°49'S, 168°39'E, 385-410 m, 28.9.1994: 1 specimen, on coral. — Stn CP 1036, 18°01'S, 168°48'E, 920-950 m, 29.9.1994: 6 specimens, on pumice. — Stn CP 1074, 15°48'S, 167°24'E, 775-798 m, 4.10.1994: 35 specimens, on basalt. — Stn CP 1076, 15°53'S, 167°42'E, 1100-1191 m, 4.10.1994: 11 specimens, on pebbles. — Stn CP 1080, 15°57'S, 167°27'E, 799-850 m, 5.10.1994: 5 specimens, on rock, shell debris. — Stn CP 1095, 15°07'S, 167°11'E, 304-320 m, 6.10.1994: 1 specimen, on rock. — Stn DW 1097, 15°05'S, 167°10'E, 281-288 m, 7.10.1994: 5 specimens, on rock. — Stn CP 1110, 14°49'S, 167°15'E, 1360 m, 8.10.1994: 2 specimens, on rock. — Stn DW 1113, 14°53'S, 167°06'E, 700-736 m, 8.10.1994: 5 specimens, on rock. — Stn CP 1114, 14°52'S, 167°03'E, 647 m, 8.10.1994: 1 specimen, on rock. — Stn CP 1125, 15°57'S, 166°38'E, 1160-1220 m, 10.10.1994: 6 specimens, on pebbles. — Stn CP 1126, 15°58'S, 166°39'E, 1210-1260 m, 11.10.1994: 7 specimens, on pebbles. — Stn CP 1129, 16°00'S, 166°39'E, 1014-1050 m, 10.10.1994: 9 specimens, on pebbles. — Stn CP 1131, 15°38'S, 167°03'E, 140-175 m, 11.10.1994: 5 specimens, on scleractinian. — Stn CP 1137, 15°41'S, 167°02'E, 360-371 m, 11.10.1994: 2 specimens, on gastropod shell.

DIAGNOSIS. — *Metaverruca* with movable tergum and scutum each having 3 articular ribs; exterior generally smooth with widely spaced growth lines; caudal appendages short.

DISCUSSION. — Specimen Ci 2423 (fig. 7b) from Vanuatu appeared at first to be a new taxon. Although the movable opercula are of similar dimension and ribbing to *M. recta*, the growth lines are much more closely spaced, and the exterior of the compartments is rather rugose. However, the mandible and first maxilla are found to fall within the *M. recta* range, the labrum is broadly curved and finely denticulate, and the cirri possess the following number of segments (r-c being the rostro-carinal diameter):

r-c (mm)	I	II	III	IV	V	VI	c.a.
7.9	13,13	10,15	19,21	24,27	25,28	28,29	9

The caudal appendages are slightly shorter than the basal segment of the pedicel of cirrus VI; and intermediate segments of cirrus VI possess 3 pairs of spines each (as in *V. recta*).

I am cautious about using the spacing of growth lines as a criterion for specific differentiation, and in this case consider that they merely reflect a growth rate variable from the norm.

M. recta is the most cosmopolitan of verrucids, with material being recorded from all seas. It is also the largest verrucid known, with r-c diameters of over 14.5 mm being recorded (BUCKERIDGE, 1994).

The three articular ribs between movable scutum and tergum, the generally inornate exterior, the fixed scutum myophore, and the short caudal appendages distinguish this from all other verrucids. This material conforms to that described in BUCKERIDGE (1994), and extends depth range, the upper limit changing from 160 to 140 m.

DISTRIBUTION. — Cosmopolitan, 140-2110 m. Miocene (New Zealand, BUCKERIDGE, 1983).

Genus *ROSTRATOVERRUC* Broch, 1922

Verruca "Sectio Rostrato-verruca" Broch, 1922: 298.

Verruca (*Rostratoverruca*) - FOSTER, 1978: 68.

Rostratoverruca - ZEVINA, 1987: 1813.

DIAGNOSIS. — Verrucids with apex of rostrum removed from margin; fixed scutum without myophore; operculum sub-parallel to base.

TYPE SPECIES. — *Verruca nexa* Darwin, 1854: 522. West Indies, 60 m.

SPECIES. — The following 8 species are assigned to this genus: *Rostratoverruca conchula* (Hoek, 1913), Timor Sea; *R. intexta* (Pilsbry, 1912), Indian Ocean - Western Pacific; *R. koehleri* (Gruvel, 1907), Bay of Bengal; *R. kruegeri* (Broch, 1922), Western Pacific; *R. murrayi* (Stubbings, 1936), Zanzibar; *R. nexa* (Darwin, 1854), West Indies; *R. sewelli* (Stubbings, 1936), Zanzibar; *R. malevichi* Zevina, 1988, South Pacific.

STRATIGRAPHIC RANGE. — Recent.

DISTRIBUTION. — West Indies and Indo-West Pacific, 60-3250 m.

Rostratoverruca intexta (Pilsbry, 1912)

Fig 8 c-d.

Verruca intexta Pilsbry, 1912: 292; 1916: 47. — NILSSON-CANTELL, 1927: 774; 1929: 468, fig. 3. — STUBBINGS, 1940: 389.

Verruca conchula Hoek, 1913: 146, figs 14-15.

Verruca (Rostratoverruca) intexta - ROSELL, 1989: 26, pl. 7 f-g; 1991: 33.

Rostratoverruca intexta - BUCKERIDGE, 1994: 119, fig 14 a-f.

MATERIAL EXAMINED. — **New Caledonia.** HALIPRO 1: stn CP 850, 21°43'S, 166°39'E, 541-580 m, 19.3.1994: 4 specimens, on sponge. — Stn CP 850, 21°43'S, 166°39'E, 541-580 m, 19.3.1994: 4 specimens, on sponge.

Loyalty Ridge. MUSORSTOM 6: stn CP 455, 21°00'S, 167°26'E, 260 m, 20.2.1989: 1 specimen, on octocoral.

Indonesia. KARUBAR: stn CP 25, 05°30'S, 132°52'E, 336-346 m, 26.10.1991: 1 specimen, on sponge. — Stn CP 62, 09°01'S, 132°42'E, 246-253 m, 1.11.1991: 3 specimens, on octocoral. — Stn CP 69, 08°42'S, 131°53'E, 356-368 m, 2.11.1991: 4 specimens, on coral.

Vanuatu. MUSORSTOM 8: stn CP 1028, 17°54'S, 168°40'E, 624-668 m, 28.9.1994: 2 specimens, on cidaroid spine.

NW Australia. "Soela": stn 116-84, 15°44'S, 120°39'E, 430-446 m, 7.4.1982: 1 specimen, on a scalpellid. — Stn 1001-86, 18°43'S, 116°35'E, 610-612 m, 7.4.1982: 2 specimens. — Stn 254-95, 18°49'S, 120°40'E, 396-400 m, 10.2.1984: 2 specimens, on hexactinellid sponge. — Stn 909-86, 13°33'S, 122°14'E, 494-496 m, 13.2.1984: 2 specimens, on cidaroid spine. — Stn 967-85, 16°56'S, 119°54'E, 436 m, 22.2.1984: 3 specimens, on hexactinellid sponge spicules. — Stn 968-85, 16°56'S, 119°53'E, 436 m, 22.2.1984: 2 specimens, on hexactinellid. — Stn 253-95, 16°56'S, 119°55'E, 436 m, 22.2.1984: 1 specimen, on hexactinellid. — Stn 966-85, 18°00'S, 118°10'E, 436 m, 24.2.1984: 1 specimen, on gastropod.

DIAGNOSIS. — *Rostratoverruca* with movable tergum and scutum each with 3 articular ribs; operculum sub-parallel to base.

DISCUSSION. — Although this material is consistent with that described in BUCKERIDGE (1994), some specimens provide evidence of the colour of the shell, which in the samples from station CP 455 is a distinct mottled, reddish-brown on white. In BUCKERIDGE (1994), the shell is described as "cream-white". The lack of colour or patterning in many collections may be attributed to the preservatives causing colour fade. One specimen was found growing within the coral *Madrepora oculata*. The verrucid had evidently reached adult size without being overgrown by the coral, indeed, the action of the cirri appear to have either prevented deposition, or eroded the coral skeleton near the verrucid orifice (fig. 8d).

DISTRIBUTION. — Indo-Pacific, 194-1002 m.

Rostratoverruca kruegeri (Broch, 1922)

Verruca Krügeri Broch, 1922: 295, figs 43-44.

Verruca (Rostratoverruca) krügeri - BROCH, 1932: 46.

Rostratoverruca kruegeri - BUCKERIDGE, 1994: 121, fig 15 a-f.

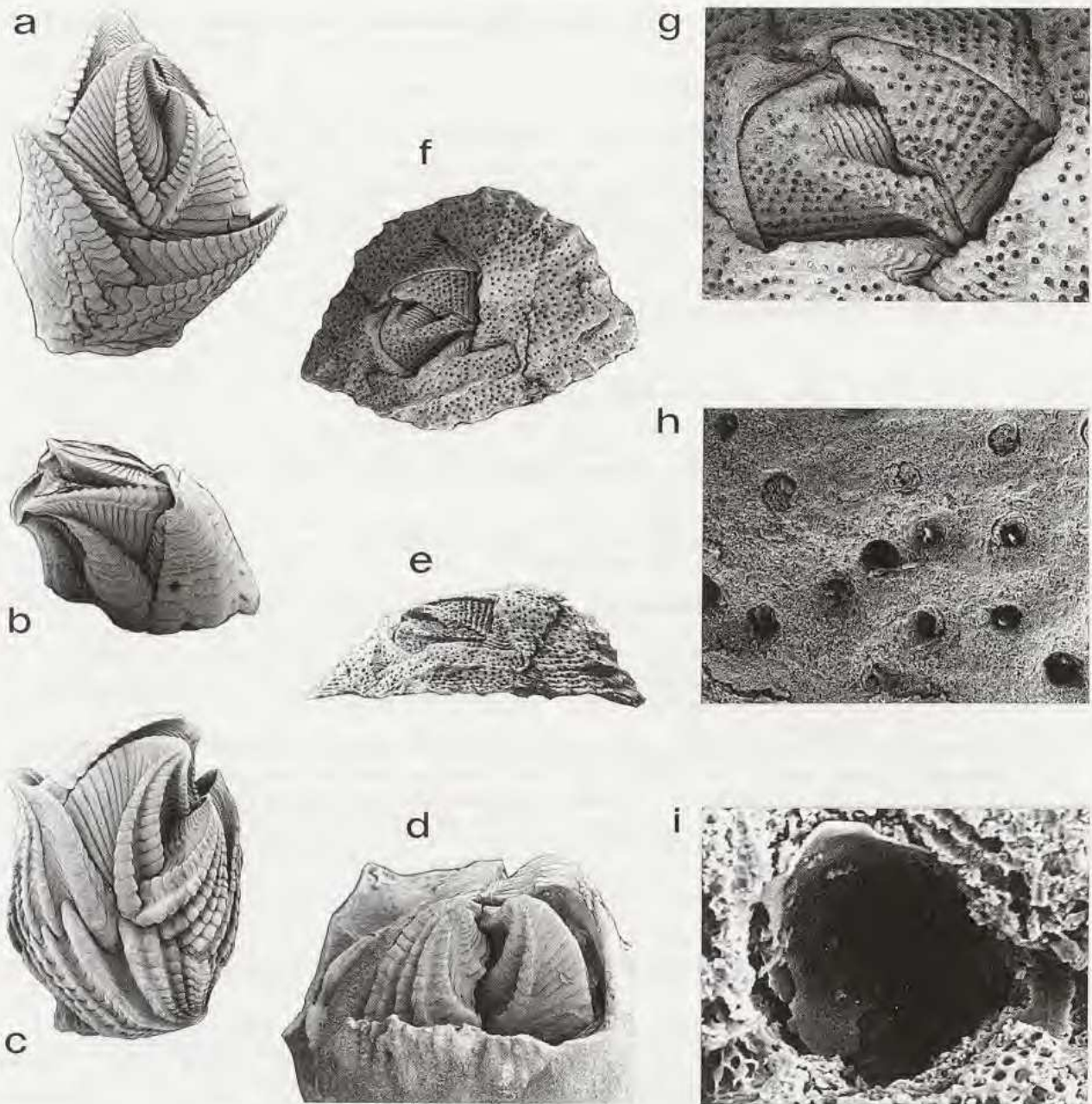


FIG. 8. — Verrucidae: Scanning Electron Microscope Photographs.

a-b, *Altiverruca nitida* (Hoek, 1883): a, complete shell (dorsal view, x 15); b, complete shell (fixed opercula view, x 15). Material from Stn CP 30.
 c-d, *Rostratoverruca intexta* (Pilsbry, 1912): c, complete shell (dorsal view, x 19). Material from Stn CP 69; d, shell growing within the coral *Madrepora oculata*, note vertical grooves in the coral adjacent to the verrucid orifice, possibly caused by cirral movement (dorsal view, x 15). Material from Stn CP 455.
 e-i, *Verruca jago* sp. nov.: e, complete shell (carino-rostral view, x 37); f, complete shell (dorsal view, x 37); g, detail of operculum from f (x 95); h, detail of porous surface from g, note desiccated organic material in centre of some pores (x 500); i, detail of pore from h (x 4000). Material from 11°51'S, 43°20'E.

MATERIAL EXAMINED. — **Vanuatu**. MUSORSTOM 8: stn CP 973, 19°21'S, 169°27'E, 460-480 m, 22.9.1994: 311 specimens, on cidaroid spines. — Stn CP 974, 19°21'S, 169°28'E, 492-520 m, 22.9.1994: 66 specimens, on

cidaroid spines. — Stn CP 975, 19°23'S, 169°28'E, 536-566 m, 22.9.1994: 4 specimens, on cidaroid spines. — Stn CP 1107, 15°05'S, 167°15'E, 397-402 m, 7.10.1994: 105 specimens, on cidaroid spines. — Stn DW 1108, 15°04'S, 167°15'E, 425-455 m, 7.10.1994: 65 specimens, on cidaroid spines.

DIAGNOSIS. — *Rostratoverruca* with fixed scutum and tergum possessing weak longitudinal ribbing; movable tergum and scutum each with 4 articular ribs.

DISCUSSION. — This material is consistent with that described in BUCKERIDGE (1994). In addition, it extends the bathymetric range from 290 to 566 m.

DISTRIBUTION. — Western Pacific, 233-566 m.

DISCUSSION

DISTRIBUTION. — The material studied in both this paper and in BUCKERIDGE (1994) was collected from depths ranging between 223 and 3680 m. This study extends the bathymetric ranges for the Indo-Southwest Pacific region, as provided in BUCKERIDGE (1994). The following provides a broad appreciation of the current known bathymetric distribution of verrucid genera for this region:

Genus	Depth range (m)	Mean (m)	No. of Stns
<i>Altiverruca</i>	412-3680	1140*	65
<i>Metaverruca</i>	203-2110	720	154
<i>Verruca</i>	196-620	377	6
<i>Brochiverruca</i>	270-700	435	7
<i>Cameraverruca</i>	380-450	415	2
<i>Rostratoverruca</i>	222-668	436	35

* only 2 specimens of *Altiverruca* were recovered from depths less than 510 m.

In the following table, data from this paper and BUCKERIDGE (1994) are combined to provide an overview of the geographic distribution of verrucid species in the Indo-Pacific region. Verrucid genera listed in the table (horizontally) are, respectively: *Verruca*, *Altiverruca*, *Cameraverruca*, *Brochiverruca*, *Metaverruca*, and *Rostratoverruca*.

Material recovered from waters off:

	<i>V. albatrossiana</i>	<i>V. jago</i>	<i>A. cristallina</i>	<i>A. galapagosa</i>	<i>A. jonesae</i>	<i>A. laeviscuta</i>	<i>A. navicula</i>	<i>A. nitida</i>	<i>C. nodiscuta</i>	<i>B. crosnieri</i>	<i>B. dens</i>	<i>B. polystriata</i>	<i>M. defayeeae</i>	<i>M. maclaughlinae</i>	<i>M. norfolkensis</i>	<i>M. pacifica</i>	<i>M. plicata</i>	<i>M. recta</i>	<i>R. intexta</i>	<i>R. kruegeri</i>
Philippines	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	X	X	X
New Caledonia	-	-	X	X	-	X	X	X	-	-	-	X	-	-	X	X	X	X	X	X
Vanuatu	-	-	X	-	X	-	-	X	-	-	-	-	X	X	-	X	X	X	X	X
Wallis and Futuna	-	-	-	-	-	-	-	X	-	-	-	-	X	-	-	X	-	X	-	-
Chesterfield	-	-	-	-	-	-	-	X	X	-	-	-	-	-	-	X	-	X	-	-
Loyalty Ridge	-	-	-	-	-	-	-	-	X	X	-	-	X	-	-	X	X	X	X	-
Indonesia	X	-	-	-	-	-	X	-	-	-	X	-	-	-	-	-	-	X	X	X
Northwest Australia	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	X	-
Grande-Comore	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-

ENDEMISM. — A number of verrucid taxa are known from only one location, often by a unique specimen. It is reassuring then that some of the rarer taxa, described in BUCKERIDGE (1994), after further collecting, have had their geographic ranges extended, e.g. *Metaverruca defayee*, *Metaverruca plicata*. The areas with highest biodiversity are also characterised by high verrucid endemism: Vanuatu has two, Loyalty Ridge one, and New Caledonia two endemic species. These three localities are situated in a transition area between tropical and subtropical zones; in addition, the ocean bathymetry is characterised by numerous highs of volcanic origin, in all providing ideal opportunities for speciation. Although the abundance of taxa recovered from waters off New Caledonia and Vanuatu mark this region as one of extraordinary verrucid diversity, I am also confident that this reflects the extensive and comprehensive collecting programme undertaken in the area by MUSORSTOM.

SUBSTRATE. — Verrucids are generally not particular in their choice of substrate, the most common being the abundant benthic debris (generally small pebbles) found at many stations, although broken shell material has also been utilised. Both *Metaverruca recta* and *Metaverruca pacifica* have been found living on gastropod shells inhabited by parapagurid crabs. These two large verrucids, like many cirripedes, are commensals, and are likely to have benefited from the feeding habits of their hosts. Some verrucids appear to be host specific, in particular *Brochiverruca* species, which are always found attached to cnidarians, and *Rostratoverruca kruegeri*, always found attached to cidaroid spines.

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